**Initial Use of Knowledge Forum for Chinese Students: Productive Discourse and Knowledge Building**

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Across different societies and sectors globally, it is now widely accepted that education in the 21st century needs to prepare citizens adept at facing changes in the knowledge-based era. Concomitant with such changes is the idea that information technology needs to be infused into teaching and learning to prepare students for the new era. How could school and classroom practices support students to become self-directed learners and knowledge workers? The goal of this paper was to examine how Chinese students participated and engaged in collaborative knowledge building in a computer supported learning environment.

Recent advances in cognitive research has shown the importance of learning as acculturating the practices of the community (Brown, Collins, & Duguid, 1989) and developing students as communities of learners and scientists (Brown, 1990; Collins, Brown, & Newman, 1989). Specifically, the theoretical notion of "knowledge building" seems particularly relevant for rethinking learning in the knowledge-based era (Bereiter and Scardamalia, 1997). Knowledge building involves more than completing school tasks or individual knowledge acquisition, it refers to students' productive practices of knowledge elaboration, creation, and advancement. In knowledge building communities, students or members are committed to developing and extending shared understandings. Knowledge is treated as conceptual artifacts that can be examined, tested, compared; and more importantly, artifacts that could be improved upon for developing deeper collective understandings.

Whereas it has been widely accepted that computer networks or web-based discussion would promote collaboration, computer supported collaborative learning takes on deeper meanings when viewed from the perspective of knowledge building. Research studies on computer-supported intentional learning environments (CSILE) now called "Knowledge Forum" primarily involved having students working on their own generated databases using notes, graphics, and commenting to build on others' work. Students generated their own problems or worked on research projects as they engaged in collaborative inquiry to advance their collective understanding. As students create, revise, and build on each others' notes in the networks, knowledge

can be objectified and represented in overt forms so that it can be continually revised and reformulated (Scardamalia & Bereiter, 1994; Scardamalia, Bereiter, & Lamon, 1994). Knowledge building, analogous to scientific inquiry, involves students working in a community pondering questions and developing new knowledge guided by productive discourse involving problem formulation, conjecturing, evaluating hypotheses, and constructing explanations. Empirical research in computer-supported intentional learning environments, (CSILE) has shown that young students could participate in high-level knowledge-seeking inquiry characteristic of scientific inquiry (Bereiter, Scardamalia, Cassells, & Hewitt, 1997). They are able to act as a community of scientists engaging in scientific discourse pursuing knowledge-related goals and extending collective understanding.

Although computer-supported learning environments offer many possibilities for knowledge building, it would seem that the emergence of knowledge-building communities would be influenced by different factors. Teachers' epistemological beliefs may play important roles in scaffolding knowledge building practices. It would be important to understand more about how teachers engage in knowledge building practices. How do teachers as learners construct an understanding about teaching and learning collaboratively? As well, it might be argued that students from different cultures might have different beliefs and conceptions about learning. For instance, there are some common beliefs that Chinese students are passive although other views have been proposed regarding the paradox of the Chinese learners (Watkins & Biggs, 1996). Therefore, examining knowledge building practices in different learning communities including teachers and students as well as examining participants from different cultural groups would help enhance our understanding of the dynamics and processes involved in knowledge building.

The goal of this paper was to examine knowledge building practices among Chinese teachers and students using Web Knowledge Forum as they collaborative to construct and extend their collective understanding. Two classroom studies were reported: The first one involves experienced primary teachers taking a course in educational psychology and the second involves Advanced-Level students learning about biology.

Knowledge building practices in these two classes would be examined using

quantitative indices and qualitative analyses of discourse patterns. Analytic Toolkit was a set of programmes developed to provide an overview of databases and for examining whether the database as a whole is on the track of moving towards a knowledge building community (Burtis, 1998). Because Web Knowledge Forum was first implemented for Chinese students, it would be interesting to see how it works and how it aligns with expected outcomes. The different indices including information about usage, connectivity, status of ideas could provide useful glimpses on student engagement on Knowledge Forum. Specifically, we sought to use information provided by Analytic Toolkit to inform us about knowledge building activity in the communities.

Knowledge building would also be examined in relation to productive discourse patterns that support the creation, elaboration, and advances in collective understanding. How do students 'talk' or how do they work together with knowledge ideas, conjectures, or interpretations in collaborative inquiry? Could these students engage in productive discourse characteristic of scientific inquiry and how is it manifested? It would be important to examine how students engage in productive discourse as these instances and examples would help teachers find ways to move students towards becoming knowledge building communities. Specifically, this paper would identify knowledge building episodes and examine how students 'talk' as they participate in collaborative inquiry.

In sum, this paper examined knowledge building among Chinese teachers and students. The specific objectives are: (a) To examine how Analytic Toolkit might provide information about knowledge building activity; (b) To characterize how students engage in productive discourse in knowledge building episodes.

**Study 1 –Developing Theory-Practice Integration among Primary School Teachers**

Although considerable attention has been given to the importance of information technology in university teaching, much less emphasis has been given to the epistemology underlying the implementation of information technology in these courses. Teacher education might espouse the belief of constructivism but few courses are designed to engage students in knowledge work. Study one was a university graduate-level courses conducted on Web Knowledge Forum using the

framework of knowledge building for promoting primary-school teachers' understanding.

## Method

### Participants

There were ten students taking a graduate course in educational psychology at The Faculty of Education at The University of Hong Kong. These students were attending an M.Ed. specialism on Primary Education. There were one male and nine female primary school educators. Eight of the participants were regular teachers and two were school principals.

It might be useful to note that primary school teachers in Hong Kong have a different background from secondary school teachers. Typically, they enter the teaching profession with a teacher certificate not a degree. More recently, it is possible for them to obtain a Bachelor of Education when they are working as teachers. Generally, primary school teachers tend to be more practically oriented and less adept at working with ideas. It is therefore of particular interest to examine how these primary school teachers engage in knowledge building.

### Implementation of the Learning Environment

Participants attended a twelve-week graduate course in educational psychology during the first semester of 1999-2000. In addition to regular teaching consisting of lectures, discussion of readings, and student presentation, students' learning was also organized around Web Knowledge Forum. Students were asked to produce computer-based learning notes to reflect on new learning, to inquire into problems, and to pursue collaborative inquiry based on what they learned. Whereas some scaffolding prompts such as 'what have you learned', 'what do you find difficult to understand?' were included at the beginning, students were reminded that these were not assignment labels but prompts to help them engage in knowledge construction. Students were also asked to write a reflection statement as part of course assignment to describe their learning. Such data provided additional data sources for examining their understanding of the course. Due to some technical problem with Web Knowledge Forum, there were times when students' names were not shown on the notes and occasions when some functions were not working. Despite such

limitations that affected student engagement on Knowledge Forum, participants did generate a database that provided some evidence of knowledge building.

## Findings

Analysis of Knowledge Building Activity Using Analytic Toolkit

To provide an overview of knowledge building activity, Analytic Toolkit was run on the database to provide some basic assessment measures.

*Overview of knowledge building activity.* The basic knowledge building measures indicated that students produced an average of 5.4 notes. The proportion of notes that had been read per user is 76% and the proportion of users' notes that were linked is 56%. There were 2 clusters of small/medium build-on trees (6-15); one cluster of medium notes (16-35) and the others were small build-on clusters. There had been some technical problems with Knowledge Forum at the beginning of the semester, hence, the number of notes was rather small. However, the percentages of notes that were read and the links among notes suggest that students were engaged in working on the database.

*Knowledge-building indices and learning.* Knowledge building indices provided were also used to examine relations between student engagement on Knowledge Forum and subsequent learning. In this study, students were asked to write a reflection statement to summarize what they have learned about the course. The reflection papers were given grades ranging from A+, A, B, C, and D that map onto a 5-point scale.

Table 1

Basic Knowledge-Building Indices and Student Performance on Posttest Learning

| | Rating of learning statements | Number of notes created | Percentage of notes that are read | Percentage of notes that are linked | Percentage of notes that are build-on |
|---|---|---|---|---|---|
| S1 | 5 | 10 | 98 | 70 | 90 |
| S2 | 5 | 14 | 90 | 79 | 93 |
| S3 | 4 | 1 | 30 | 100 | 100 |
| S4 | 4 | 10 | 66 | 70 | 80 |
| S5 | 3 | 4 | 92 | 50 | 50 |
| S6 | 3 | 4 | 44 | 75 | 75 |
| S7 | 2 | 2 | 67 | 0 | 0 |
| S8 | 2 | 2 | 90 | 50 | 50 |
| S9 | 2 | 1 | 87 | 0 | 0 |
| S10 | 1 | 5 | 77 | 40 | 60 |

Table 1 shows the total number of notes written, percentage of notes in the database read by the student, percentage of notes linked to others, and percentage of notes written as comments. Students were divided into two groups based on their scores on the reflection statements (Low: 1-2; High: 3-5). Statistical analyses using t-tests indicated that the two groups differed significantly on the percentage of notes linked $t(8) = 3.8$, $p<.01$; and the percentage of build-on notes, $t(8) = 3.1$, $p<.05$. Differences between the total number of notes were marginally significant, $t(8) = 2.1$, $p<.08$. There were no differences in the percentage of notes read by students. These findings indicated that students' posttest learning was related to knowledge building indices. Clearly, no causal relations should be inferred, the association suggests that Analytic Toolkit could provide some useful information for examining student learning.

Characterization of Productive Discourse

Knowledge building was also examined in relation to how teachers participated in productive discourse in improving collective understanding.

At the beginning of the course, participants' comments reflected a rather superficial approach to knowledge construction. They might react generally to the readings or merely paraphrased the text. A different variant of computer notes were also observed as participants focused on the actual examples of teaching. Some examples are as follows:

- The reading is interesting [and I think] that would help my students in constructing their knowledge [CLK]
- A constructivist teacher should give enough opportunity for students to present their own ideas [TYP]
- I really agree with your point…To support each theme, planning and construction of ideas are included on bulletin boards, parent letters, and a wide variety of classroom experiences [ISY]

**Deepening Inquiry – Developing Theory-Practice Relations**

As the discourse continued, participants were generally more capable of improving the quality of their notes. As participants proceeded with their discussion, some began posing questions that helped to initiate deeper discussion. An example is included in the following:

*Posing a Question*

- I found that the concept of teaching [constructivism] introduced is quite close to my idea theoretically, but I do really want to learn how to apply it [KSH]

The idea of how to apply some idea is rather simple and commonplace in teacher discussion in university courses. However, this participant did make some attempt to reflect on the new information in relation to her existing beliefs. Knowledge Forum provided the opportunity for the idea to be treated as an object of inquiry. Such question did play a role in initiating deeper inquiry and move the discourse forward. A student responded as follows:

*Extending the Idea and Reflecting*

- Let's take English language as an example, a primary four class learns making sugggestions by using the sentence structure "Let's go somewhere to do something."…If the activity is limited to the pupils to learn the keywords/phrases and reproduce similar sentences, sure, their focus is on the

sentence, not making suggestions. To make learning meaningful to them, teacher should design a context for the pupils to make suggestions…The lessons could break 5 minutes earlier for [making] good suggestions: "Let's go to the playground", "Let's go to the canteen" and WE DID. *To me learning process consists of understanding, practicing, and using*. It looks like some steps but actually it is interpreted from pupils' point of view [LWK]

Although this participant was not developing any sophisticated ideas yet, he built on the question of application and related to a case scenario in his teaching. Interestingly, the teacher goes beyond providing practical solutions. After giving the examples, he constructed some personal understanding as to what he believed learning process is about. Knowledge ideas are examined and refined as the participants continued their discussion.

*Relating and Elaborating the Idea*

- Your point--Let student apply what they have learned reminded me of providing the authentic situation when designing a learning task. This is also the most difficult part. It takes time, space, resources. If the curriculum is organized around topics, it can be done more easily. [KSH]

Such interactions have led to further thoughts and questions on theory-practice integration. Whereas this participant had noted the problem of school constraints, she had gone further in seeing possibilities of the curriculum to be organized around topics. As the discourse continued, students were more involved in working out the relationships between theory and practice. An example is given as follows:

*Examining and Constructing the Idea*

- *The [idea of] constructivism brings the idea of 'child-centred' types of teaching and learning in which prior knowledge of children and learning approaches influence the 'product' of the learning process*. Being a teacher, make students to be dominant in the classroom, let them select what to learn is of prime concern. *But how can teachers achieve that goal? How can we act as the mediator in the child's learning process?* In the classroom, I myself have experienced the mode of cooperative learning. In the lesson, children are divided into groups, assigned to prepare a topic which their classmates have to study. Before the lesson, students have to collect information about the subject, enrich themselves to be the 'expert' in that subject matter. During that lesson, students were assigned to 'teach' their classmates. After that, classmates were asked to report what they have learnt for assessing their learning. *I am not too sure if the lesson conducted was a constructivist one, but I found myself and my students had a good time during that lesson*. Also, my students reflected that they learnt a lot about the subject in the

preparation process and learnt how to communicate with classmates. [LYK]

Here the student had moved up the level as she stated her understanding of constructivism, related her teaching experience, and then wondered how her teaching might be considered constructivist. She was not merely working at the level of paraphrasing the text or describing some experiences; she seemed to be constructing the relations between day to day concerns and her own understanding of constructivism.

Although systematic knowledge change had not been tracked, it is interesting to note that these Chinese primary school teachers brought up in a school culture of examination might be reconsidering their ways of thinking about teaching and learning. After synthesizing some ideas in the database, a teacher wrote about her thoughts to the community:

*Towards Developing Collective Knowledge*

- *We have read and discussed a lot about constructivist teaching and learning. I think we all agree that it is good for our pupils. But how far is it important?* If we use the traditional way of 'transmitting' knowledge, our pupils can still pass the examination and go onto Band 1 English secondary schools. *So is constructivist teaching really that important*? …According to futurists, computers can be used to transmit, memorize, store, and retrieve information far more quickly and accurately than human can. So different forms of knowledge and different cognitive skills will be required for our pupils to gain success in the 21st century. They will be expected to think critically about what they have heard and read, to solve problems, and to create new ideas. See, our pupils need to be taught how to construct knowledge in order to 'fit' the trend in the near future, especially from the elementary stage. *Facing the challenge of the 21st century, let's start constructivist teaching now*! [CLK]

It is not possible to ascertain whether this teacher had made some conceptual change about teaching and learning. It is at least interesting to note she attempted to "rise above" and synthesize the views of the community [*we have read and discussed…we all agree*] as she pondered and constructed her understanding in relation to the contextual factors in the school system [they can *go onto Band 1 schools*]. Her appeal to start constructivist teaching [*Let's start constructivist teaching*]

suggests that discoursing with the community as she tried to work at improving their collective understanding of teaching and learning.

**Study II – Conceptual Understanding in Biology for Advanced-Level Students**

This study reports the first experience of implementing Web Knowledge Forum in the regular high-school setting in Hong Kong. Although the project has just gone on for several weeks, there is some evidence indicating these secondary school students were on the way towards developing into a knowledge building community.

**Method**

Participants

The class consisted of seventeen Advanced-Level students (equivalent to Grade 12) taking a course in Biology in a regular high school in Hong Kong. Due to technical problems with computer access, five students did not participate. There were twelve students in this group participating on Web Knowledge Forum. Local schools in Hong Kong are highly streamed according to ability, and students in this school are of average ability. The course was taught by a very experienced biology teacher. As in some other research projects on knowledge building, the teacher is also the researcher. The teacher worked closely with the university researcher in the design and implementation of the learning environment.

Similar to most high schools in Hong Kong, some kind of mixed-code (English and Chinese) classroom language is employed although there is now a general shift to the Chinese medium of instruction in most high schools. Whereas mixed code teaching is adopted in the classroom, Advanced-Level students study English textbooks and they have to write the public examination papers in English. These students wrote in English on Web Knowledge Forum. Occasionally some students would put in some Chinese explanations to elaborate what they meant.

Implementation of the Learning Environment

In implementing Web Knowledge Forum, we designed the learning situations to adapt to the contextual factors of the local school settings. Unlike studies conducted in CSILE elementary classrooms where teachers and students structured the entire curriculum around research projects during class time, this learning environment was

implemented similar to university courses. Students were taught the regular Advanced-Level Biology curriculum and they were asked to deepen and extend their understanding through collaborative problem inquiry on Knowledge Forum.

Primarily, Hong Kong students were taught a very packed curriculum to prepare for the highly competitive examination. The teacher remarked there was little opportunity for students to inquire into the topics and little time for questioning or investigation. Therefore, he considered that Web Knowledge Forum actually provided a useful learning environment for students to construct deeper understanding and to inquire into areas that need further explanations. There were however some contextual constraints as some students did not have computers at home and there was limited access to computers at school. Five students were given permission not to participate.

Despite these limitations, the teacher was able to develop a knowledge building environment for students. Although web-based discussion has now become more popular in schools, Knowledge Forum was used in ways that go beyond posting assignments or merely providing on-line tutorial help for students. Specifically, the course was organized and informed by the epistemology of knowledge building in which students had to generate questions, pose alternative theories/hypothesis, bring in new information, consider different students' views, and construct or reconstruct their own understanding.

In the initial use of Knowledge Forum, students were asked to write in two different views. They were asked (a) to generate questions and problems related to their learning and to engage in collaborative inquiry, that is, to help each other work out the problems; and (b) to discuss their thoughts, understandings, and questions related to an essay question posed by the teacher. Students would enter the notes and comments after class in their spare time as in the university study. Although some minimum recognition in terms of course grade was given to their contributions to Knowledge Forum, there were not a fixed amount of notes that need to be written. This in itself is quite a departure from the usual assessment practices and standards in Hong Kong schools.

**Findings**

Analysis of Knowledge Building Using Analytic ToolKit

*Overview of Class Activity*. The basic knowledge building measures indicated that students produced an average of 9.4 notes over the past few weeks. The proportion of notes that had been read per user was 65% and the proportion of users' notes that were linked was 73%. There were two clusters of medium build-on notes (16-35), seven clusters of small/medium build-on notes (6-15); and six small clusters (2-5). In view of the relatively short time since the database had started, it appears that students were actively engaged on Knowledge Forum.

*Knowledge Building Activity for Student and Teacher-Generated Questions.* This analysis showed that Analytic Toolkit could be used in different ways to provide information on knowledge building activity in the community. There were two different views: one on teacher-generated questions and the other on student-generated questions. Table 2 shows that students created more notes on their self-generated questions compared to teacher-generated questions. The notes were more connected with more links, and the percentage of keywords is higher. However, students tend to read more of the computer notes written on teacher questions.

Table 2

Knowledge Building Indices for Teacher-Generated and Student-Generated Questions

| | View on Teacher-Generated Questions | View on Student-Generated Questions |
|---|---|---|
| Number of notes contributed per user | 1.46 | 7.77 |
| Percentage of notes read | 73% | 63% |
| Percentage of notes linked | 58% | 72% |
| Percentage of notes with keywords | 10% | 43% |

Characterization of Productive Discourse

Two knowledge-building episodes are included to characterize how students engaged in productive discourse in advancing their understanding. The first example shows how a low-level text-based question was progressively refined as students worked at understanding the principles. The second example shows collaborative problem solving on a knowledge-based problem that involves resolving discrepancy in understanding. Both examples show how students were engaged in discourse patterns that support the advances of understanding.

***Example 1 --From Premature Closure to Deepening Inquiry***

*Asking a Concrete Question*

The discourse was initiated by someone asking a rather low-level factual question about NADP, an electron acceptor molecule important in the process of photosynthesis.

- What is the form of reduced 'NADP'? This makes me feel puzzled, what do you think? I think the reduce form of 'NADP' is "NADP+. And what is the original form of 'reduced NADP+? Do you know what I mean? Please give me some suggestions. [TKW]

*Giving Answers without Explanations*

- I think it is like this….

NADP+ --------NADPH + H + [WKF]

*Premature Closure*

- Thank you for your suggestions. In fact, I have clarified my concept. [TKW]

The question posed by TKW was responded to although no explanation was provided. It was not clear whether the student (TKW) had indeed understood but she merely thanked her classmate and prematurely closed the discussion.

*Recognizing Conflict and Posing Query*

It would seem that the question-answer sequence could merely stop here. An answer had been given and the student had acknowledged the response with thanks.

However, as ideas are represented on the database, students had the opportunity to ponder about them and to pose questions. The note was followed by another question that deepened the discourse as another student might recognize some conflict and set out to clarify her understanding. The factual question and answer was now turned into one that needs some explanation.

- Do you mean that NADP actually bear a +ve charge before it accepts the electrons? [YHM]

*Exposing Problem in Understanding*

- I didn't read the notes…but I remember Mr Chui said that …[WKF]

Interestingly, although WKF was able to give the answer about the form of NADP in the earlier discussion, he did not really give any explanations. The question asking for explanation helped to expose possible problems with this student or the class' collective understanding. It was not uncommon here for students to refer to the teacher as authority sources of information. The impasse was broken by another student joining the discourse.

*Formulating Problems and Conjecturing.*

- I think the form is NADP and after [it has] accepted electron, it changes to NADPH+H+ but *I don't know why* after NADP has received e-, it is positive in charge? Is it because it obtains 2 hydrogen atoms after it receives a e- as it wants to make itself more stable? And so it is finally positive in charge? But isn't it that most stable is having no charge? Why doesn't it just throw the e- away and become stable? (That's what happens in CO2 fixation that e- is thrown to CO2 and reduce CO2 to become C6H1206) [CWS]

The problem led to some deepening inquiry by another student bringing in what he knows (*I think…*) and then identifying his knowledge conflict (*I don't know why…*). He then generated some different conjectures for addressing his problems (*Is it because…But isn't it…)* relating to other information he knows (*That's what happens).* The initial simple question-answer form has now been deepened to some inquiry about principles and explanations about NADP. Whereas the student did not understand yet, he was engaged in examining other ideas and his question also led to further knowledge advances in the community.

*Constructing Scientific Explanations*.

- I think that NADP+ is the original form, and after it receives 2 electrons, it is not stable and thus has to get 2H+ ions to stable the charge. It then becomes NADPH+H+. Do you think the above explanation is correct? [YHM]

With the problem more clearly formulated, another student proposed her explanations. It might also be interesting to note that students did not merely ask whether her answer is correct. In the nature of developing scientific understanding, she asked whether her *explanation* is correct.

This knowledge building episode indicated how a rather factual or text-based question was upgraded to a high-level one involving conceptual principles among students engaged in collaborative knowledge building.

***Example 2 -- Collaborative Problem-Centred inquiry***

This second example showed how these students formulated knowledge-based questions and engaged in collaborative problem solving sustained by productive discourse.

*Formulating Problem relating to world knowledge*

- Teacher said human can undergo anaerobic respiration for only a few minutes. It is because O2 is the final electron acceptor and completes the oxidation of respiration. Teacher also said that the ATP in our body is not much and if we do not breathe, there would not be enough ATP for us to use and we will die… *If so, [how can] divers stay in the water for a long time. Is it because they have more ATP than we do so they do not need to breathe for a long time?*….[SK]

Typically, Hong Kong students learn the syllabus for the examination. In this context, the student posed what some might call a non-syllabus question but one that connects textbook knowledge to real-world understanding. As the student learned the concepts of aerobic and anaerobic respiration, he formulated a problem about how *divers could swim under water for so long*. In formulating the question, he related to other information and identified sources of difficulty. Although he had not stated very clearly, he conjectured and put forth a hypothesis stating that the amount

of ATP stored in the body of divers might enable them to dive a long time under water.

*Formulating different conjectures/hypotheses*

The problem had led to other students conjecturing why divers could stay under water and the hypothesis of lung capacity was proposed. Although the hypothesis was not clearly formulated, that piece of information might constitute part of the puzzle in solving the problem.

- …some divers can tolerate longer time than someone else because of lung capacity, i.e., the capacity is greater than others. This is just my opinion. [TKW]

*Examining and refining understanding*

To tackle the problem of why divers could stay in the water for so long, students need to widen the basis of discussion and to construct and clarify their understanding about aerobic and anaerobic respiration. Using the example of runners, students were engaged in productive discussion as they examine, criticize, and extend each others' ideas during which certain knowledge ideas were refined. The following sequence of exchange indicates such refinement of idea:

- Our body will undergo anaerobic respiration when there is not enough oxygen supply. Take the long runner as an example, the body will undergo anaerobic respiration too…[CWK]
- Don't use long runners as examples – should use short runners – Do you understand why? [WKF]
- I think the condition that we will undergo anaerobic respiration is when we are lack of oxygen…what do you think? [TKW]
- I agree with Frederick that you should use short runners as an example.[YHM]
- The case of long distance runner is not suitable in this case. Because in the case of long distance runner the ratio of anaerobic to aerobic respiration is very low. Otherwise, the runner cannot withstand so much oxygen debt. [LYC]

*Including New information*

Whereas students were discussing about long and short runners in clarifying their understanding of anaerobic respiration, they were still focused on the problem of the divers. A new piece of information was brought in by another student and he also made some new conjectures about relaxation in diving.

- In fact, [the oxygen content] is not too low in the air that we breathed out. OR in

other words there is still oxygen [that] we can use….I watched a TV programme which talked about "free diving", someone can try their best on diving for even 4 or 5 minutes; some can dive for 7 minutes without O2 supply by controlling the whole body by their will. But they must be very relaxed when they are diving. So I think energy producing problem in the first few minutes is not the most important limiting factor but our will and our relaxation. Do you agree with me? [LYC]

*Reformulating Problem.*

The student who formulated the original problem was keeping track of the discussion and still pursuing his knowledge goals. In the following two notes one involving coauthoring, he synthesized some points from different classmates and reexamined his earlier hypothesis about the amount of ATP stored in the body that enables the diver to stay for a long time under water. It seems he was monitoring and reformulating his problem with the improvement of the community knowledge.

- Diver's can't breathe under water…But I agree with you Dicky. The unbreathed air contained oxygen. Then I think if they can breathe more at one time, they can dive for a longer period…[SK]
- As So mentioned, the ATP in our body is very low, it is not enough. So if we are relaxing, we can decrease our body energy use and the ATP can maintain us for a longer time….[SK and CWM]

*Constructing Scientific Explanations*

As these different ideas on ATP, lung capacity, anaerobic respiration, oxygen in breathed air, relaxation and energy use were presented, examined, queried, and extended by different students in this community, these ideas culminated as a student synthesized and proposed a scientific explanation. This student was taking what was collaboratively constructed and taking it further. It would not be possible for that student to construct this explanation without such collaborative inquiry.

- If there is no oxygen to act as the final electron receptor, then we cannot proceed with aerobic respiration but anaerobic respiration instead. A lot less ATP can be produced by anaerobic respiration. I don't think divers can dive for a long time because they have more ATP in their body, but because they know how to take a deeper breath so that they could [still have] oxygen to act as the electron receptor

and proceed aerobic respiration [while he is diving]. And they know how to relax themselves so as to minimize their energy need.

*Reexamining own understanding*

There is also some evidence of changes in personal understanding in light of advances in collective understanding. The student who originally formulated the problem went back to the original question. It is unclear whether he had debugged his 'theory' about more ATP for divers, anyway, he no longer mentioned that. It is interesting that the student was well able to detect relevant from irrelevant information and constructed his new understanding.

- After seeing Dicky, Molemole, and Helen's point, I think I know the answer. The diver know how to take a deep breath and when they are in the water, they do not breathe out the air and make the most O2 in their body [that] can [be] used up. They can have aerobic respiration in the water and swim for a long time!

In summary, these two knowledge-building episodes one involving moving a factual text-related question to an explanatory one involving understanding; and the other involving a knowledge-based question indicated that the Chinese students were engaged in productive discourse as they posed question, conjectured, recognized conflict, queried others' views, and constructed explanations. In examining their own and others' ideas as objects of inquiry, they were able to make advances in their collective and personal understanding.

## Discussion

This study examined the initial use of Knowledge Forum among experienced primary teachers and Advanced-level biology students in Hong Kong. Specifically, we sought to characterize knowledge building practices among these two communities using quantitative indices provided by Analytic Toolkit and qualitative analyses identifying productive discourse patterns.

Analytic Toolkit was employed to provide some information about how Web Knowledge Forum works. The programme was successfully run on the two databases with findings that generally aligned with our expectation. Although the number of notes written was relatively small in Study 1, the proportions of notes that were

linked (Study 1 – 56%; Study 2 – 73%) and read (Study 1 – 76% Study 2 – 65%) suggested that students were engaged in browsing, linking, and building on other notes. Some basic knowledge building activity seems to be going on. Although there was no comparison figures with other databases, it has been shown that connectivity is a useful index for examining students' knowledge building work (Burtis, 1997).

Analytic Toolkit also provided us with some other interesting information: In Study One, the basic knowledge-building indices showed a fairly good match with students' learning measured by their post-semester reflection statements. Students who performed better in the course created more notes, wrote more build-on notes, and their notes were better connected with others. Students more engaged in knowledge building activity on Knowledge Forum seemed to learn the materials more deeply. Apparently, causal relations could not be drawn as good students might be more engaged and they also wrote better reflection papers. Nevertheless, the findings at least suggest that the indices are quite useful reflecting student engagement in knowledge building.

In Study Two, Analytic Toolkit was run to compare knowledge building activity on two views: Student-generated and teacher-generated questions. We found students wrote more notes, used more keywords, and their notes had higher connectivity when they were asked to inquire into questions they generated. Such findings are interesting because it contradicts the common beliefs that Chinese students tend to follow teacher instruction. When given the opportunity to set learning goals, they were actually more involved in working on problems generated by themselves. Similar to text-based and knowledge-based questions (Scardamalia & Bereiter, 1992), questions generated by students included text clarification as well as wonderment questions that aimed to resolve knowledge conflict.

It might not be most appropriate to compare the two databases because the settings were very different. However, the indices did generally align with our expectation—more knowledge building activity was going on among the Advanced-Level biology students. These students wrote more notes and the proportions of links were higher. Although no systematic analyses were conducted, more knowledge-building episodes might be identified among the biology students. This is quite interesting because experienced teachers should have more cognitive resources than high-school students. However, knowledge building is not about how much students

know, it is about how members collaborate and work to improve their collective knowledge. As the graduate course was conducted weekly whereas the biology class went on almost everyday at school, it is reasonable that there would be more opportunity for sustained knowledge building inquiry for these students.

The two databases were fairly small at present; however, for large databases, it was easy for notes to get buried. Analytic Toolkit could also provide indices to show which students worked with whom; and what ideas or notes received much attention. Such information could serve as pointers for identifying expert practices and knowledge building episodes in the community. Further work might involve using the indices for monitoring student work or giving students control and helping them evaluate their knowledge building activity using such information.

Qualitative analyses were conducted to examine students' knowledge building practices, that is, how they were engaged in working towards deeper collective understanding. Some different patterns of knowledge-seeking activity were identified. For the primary teachers, some were concerned with paraphrasing the text statements, other responses showed they were concerned with practical classroom experiences. However, more sophisticated responses suggested they were working with theory-practice relations. For the biology students, some questions were factual and some statements consisted of answers without explanations. However, there were also many instances showing students' engagement in pondering about their ideas and working at constructing explanations. Consistent with research on children's epistemological beliefs about knowledge-seeking inquiry, differences could be observed among participants in the knowledge building communities (Chan, 1999; Hakkarainen and Lipponen, 1996).

Although differences could be observed as to how participants dealt with knowledge and ideas, what is more important is how students collectively worked with knowledge production and elaboration. On both databases, there was some gradual progression from rather simplistic statements, text-based, and syllabus-bound questions to more sophisticated reflections and puzzlements. As ideas were posted on Knowledge Forum, students could gain access to different models of understanding; and such scaffolding effects might help them improve their notes. More importantly, the computer networks also provided the environments for sustaining productive

discourse among members so that “incomplete” knowledge ideas could be inquired, refined, examined, and improved in the community.

How did students collaborate to advance their knowledge and what are the characteristics of the discourse that sustain the inquiry? For the primary teachers, focus was placed on inquiring the relations between theory and practice. The discourse seems to advance when some question were posed; and such questions could then initiate and steer the discussion as participants built on and extended each others’ ideas. Knowledge building also proceeds when students were working at advancing collective knowledge: Some student seemed to be working at synthesizing other students’ views and trying to examine or influence the community’s beliefs. Even though there might not be consensus, these students seemed to be working in a discourse community as they worked at improving the collective knowledge.

The biology students provided perhaps clearer examples of knowledge building evidenced by collaborative problem centred inquiry. Analogous to scientific inquiry, these students acted like a community of scientists engaging in scientific discourse. Despite misconceptions, confusions, or even chaos as they worked on the problems, these students were able to construct some rather sensible and ‘scientific’ explanations and improve on their understanding. It was quite clear that none of these students could have constructed the explanations without the collaborative work of other members of the community. Productive discourse was characterized by a gradual progression towards deepening inquiry as students engaged in problem generation, conjecturing, hypothesizing, recognition of conflict, extension of ideas, synthesis of views; co-construction of explanations; and reformulation of understanding. In the process, they were committed to developing understanding; they brought in new information; and were open to different views. Such findings are consistent with the characterization of progressive discourse in scientific understanding. In terms of knowledge building, these students were involved in productive knowledge practices as they developed their conjectures and ‘theories’, examined and criticized them, thus improving these ideas and understandings (Bereiter et al., 1997).

Although it might be considered that Chinese students had difficulty with discussion, these findings suggest that when given the opportunity, they could engage in collaborative knowledge construction. The teacher participants agreed and

disagreed with each other as they extended their knowledge and subject different ideas to inquiry. For the high school students, the teacher reflected that the Knowledge Forum provided the opportunity for the students to pose questions and thoughts he never considered they would have. In fact, they had generated problems well beyond the curriculum that extend into more difficult realms of scientific knowledge. These students were engaged in scientific thinking and productive knowledge practices as they inquired and co-construct new understanding. Possibly it could even be said that these students are creating knowledge. Contrary to the idea that Chinese students are passive learners, these students seemed able to set knowledge-related goals and engage in working with refining and constructing knowledge.

Educational policies and curriculum documents in different countries have often included some mandated educational objectives on helping students think and learn better. More recent terminology included helping students to become self-directed learners adept at collaborating with others. These educational goals and objectives are also emphasized in the current educational reforms on lifelong learning in Hong Kong (Education Commission, 2000). However, how such goals and objectives are to be realized are rather unclear to most educators. From the perspective of knowledge building, it would be important to engage teachers and students in the participation of knowledge construction. Knowledge Forum would provide a useful context for examining how students and teachers participate in knowledge building practices in creating and working with new knowledge.

Research and implementation of CSILE and Knowledge Forum has now taken place in different countries and these two databases provided additional information on knowledge building in other cultural communities. This study indicated that Analytic Toolkit could provide some useful information. Both groups show some evidence of developing deepening inquiry in their discourse. In particular, it seems interesting that productive discourse observed among these Chinese high-school students using English as second language were remarkably similar to patterns identified in other knowledge building communities. These biology students were engaged in knowledge building as their ideas were inquired, criticized, extended, explained, synthesized, and refined for improving collective understanding. The project is still ongoing and future work would be conducted to examine whether these

students might experience conceptual change and how that might be related to their knowledge work. Furthermore, how students could move from fragmentary to collective understandings needs to be more closely examined so knowledge building could be promoted. Finally, teacher factors seem to play some most predominant roles. How teacher beliefs and scaffolding might foster knowledge building are important research issues to be investigated.

## References


Bereiter, C. & Scardamalia, M. (1996). Rethinking learning. In D. R. Olson & N. Torrance (Eds.)., The handbook of education and human development (pp. 485-513). Blackwell Publishers.

Bereiter, C., Scardamalia, M., Cassella, C., Hewitt, J. (1997). Postmodernism, knowledge building and elementary science. Elementary School Journal, 97 (4), 329-340.

Brown, A. L., & Campione, J. C. (1990). Communities of learning and thinking or a context by any other name. Contributions to Human Development, 21, 108-126.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. Educational Researcher, 18, 32-48.

Burtis, J. (1998). Analytic Toolkit for Knowledge Forum. Centre for Applied Cognitive Science, The Ontario Institute for Studies in Education/University of Toronto.

Chan, C.K.K (1999). Knowledge building and belief change among teachers in computer supported collaborative learning. Paper presented at the symposium on "Towards Practices of Knowledge Building in Education" in the 8th Biennial Meeting of the European Association for Research on Learning and Instruction, Goteborg, Sweden

Collins, A., Brown, J. S., & Newman, S. E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing and mathematics. In L. B. Resnick (Ed.) Knowing, learning and instruction: Essays in honor of Robert Glaser (pp. 453-494). Hillsdale, NJ: Lawrence Erlbaum Associates.

Hakkarainen, K., & Lipponen, L. (April, 1998). Epistemology of inquiry and computer-supported collaborative learning. Paper presented at the annual meeting of the American Educational Research Association, San Diego.

Oshima, J., Scardamalia, M., & Bereiter, C. (1996). Collaborative learning processes associated with high and low conceptual progress. Instructional Science, 24, 125-155.

Scardamalia, M. & Bereiter, C. (1994). Computer support for knowledge-building communities. The Journal of the Learning Sciences, 3, 265-283.

Scardamalia, M., Bereiter, C., & Lamon, M. (1994). The CSILE project: Trying to bring the classroom into World 3. In K. McGilly (Ed.), Classroom lessons: Integrating cognitive theory and classroom practice (pp. 201-228). Cambridge, MA: MIT Press.

Scardamalia, M., Bereiter, C., McLean, R., Swallow, J., & Woodruff, E. (1989). Computer-supported intentional learning environments. Journal of Educational Computing Research, 5, 51-68.